

## End Cap Assembly

This invention relates to an electric motor and in particular, to motors with improved EMI characteristics.

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In many applications an electric motor is required which has low EMI emissions. In the past, this has been achieved by shielding the electric motor as much as possible and/or by adding EMI or noise suppression components such as chokes, capacitors and diodes into the motor circuitry, usually within the motor itself mounted on the end cap or even directly on the rotor.

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These measures have had limited success but there has always been a trade off between cost and performance. As EMI requirements are becoming more strict, better EMI suppression is required.

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Thus, there is a need for a miniature PMDC motor with reduced EMI emissions.

The present invention provides such a motor by incorporating a chip type EMI filter circuit into the circuitry of the motor.

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Accordingly, the present invention provides an end cap for a miniature electric motor, the end cap having a body of insulating material and a cover of conductive material, wherein the body supports two brushes for making sliding contact with a commutator, two motor terminals for connecting a power supply to the brushes and a chip type EMI device having at least three terminals including: two input terminals, respectively connected to the two motor terminals; and at least one earth terminal electrically connected to the conductive cover.

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Preferably, the chip type EMI device has two earth terminals which are connected to the conductive cover.

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Preferably, the cover has an opening in which the EMI device is located and the conductive spring engages an edge of the opening to establish electrical contact between the or each earth terminal of the EMI device and the cover.

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Preferably, the device is located in a compartment integrally formed in the body and is retained in the compartment by the conductive spring.

One preferred embodiment of the present invention will now be described, by way of example only, in which:

- 5 Figure 1 is a perspective view of an end cap according to the preferred embodiment of the present invention;

Figure 2 is an inside perspective view of the end cap of Figure 1;

- 10 Figure 3 is a perspective view of a cover being a part of the end cap of Figure 1;

Figure 4 is a perspective view of a body of the end cap of Figure 1;

Figure 5 depicts an EMI device as used in Figure 1;

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Figure 6 depicts an earth spring as used in Figure 1;

Figure 7 depicts a brush leaf as shown in Figure 2;

- 20 Figure 8 depicts a brush holder as shown in Figure 2;

Figure 9 depicts a spring connector as shown in Figure 2;

- 25 Figure 10 is a detail view of the connection of the brush holder with the spring connector of Figure 2; and

Figure 11 is a detail view of the assembly of the earth spring of Figure 6.

- 30 The preferred end cap 20 is shown in Figures 1 and 2, Figure 1 being a plan view or outside view and Figure 2 being a view from below or an inside view as this side of the end cap is covered in use by a motor housing. The end cap has a body 22 of insulating material and is preferably a plastics injection molded part. The outer side of the end cap is covered by a conductive cover 24 which is pressed from sheet metal. The cover has a central boss 26 forming a retainer for a bearing for a rotor shaft.

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As shown in Figure 3, the cover 24 has four round holes 28 and two rectangular holes 30, 32. The four round holes 28 receive fixing posts 34 formed on the body 22 for fixing the cover 24 to the body by a staking process. One of the rectangular holes 30

accommodates the EMI device 36 while the other 32 receives a projection 38 formed on the body. The posts 34 and projection 38 are more clearly shown in Figure 4. Figure 4 also shows an integral compartment 40 formed on the upper surface of the body for receiving the EMI device. The compartment 40 is divided into halves by a slot 42.

The EMI device is shown in Figure 5. It is a chip type device being a small rectangular prism with input terminals 44 at each axial end and two earth terminals 46 midway between the axial ends, one on each of the narrower side faces. The preferred EMI device is a four terminal layered architecture noise canceling chip device. An earth connector 48 in the form of a W-shaped conductive wire spring, as shown in Figure 6, connects both earth terminals 46 to the cover 24.

The body 22 supports the electrical components of the end cap. Figure 2 shows the body supporting motor terminals 50, fingerleaf brushes 52, brush holders 54 and spring connectors 56. The fingerleaf brushes 52 (Figure 7) are strips of a resiliently flexible conductive material such as beryllium copper. The distal end of the brush leaf has been separated into three fingers 58, forming a co-called fingerleaf brush. Each brush 52 is connected, by upset rivets 60, to a brush holder 54 which fixes the brush 52 to the body 22. Motor terminals 50 extend from apertures in the body along grooves 64 to make resilient contact with the brush holders 54. While female motor terminals are shown, male terminals are also possible.

The brush holders 54, more clearly shown in Figure 8, have a barb 66 which is pressed into a slot 68 in the body for fixing the brush holder in position and hence, the brushes. The spring connectors 56 make resilient contact with the respective brush holders and extend through apertures 70 in the body into opposite ends of the compartment 40 for the EMI device 36. The spring connectors 56 (Figure 9) are of conductive spring material such as brass and the distal ends are arranged to make resilient electrical contact with the terminals 44 of the EMI device 36 while accommodating variations in size between individual EMI devices due to manufacturing tolerances.

Figure 10 shows in detail the arrangement of a spring connector 56. The brush leaf 52 is fixed to the brush holder 54 by upset rivets 60 and the join is located in a slot 72 in the body. The spring connector has a 'U'-shaped end which is pressed into the slot 72 with the brush holder 54 and the brush leaf 52. The end has dimples 74 for making better contact with the brush holder 54. The spring connector 56 thus straddles the

respective brush holder 54, brush leaf 52 and a wall 76 of the body 22 with the other end extending through the body and into the compartment 40 for the EMI device 36 located on the other side of the body 22.

- 5 Figure 11 illustrates in detail the earth connection. The EMI device has two earth terminals 46 located midway along the narrower sides. The earth spring 48, which is similar to a 'W' in shape is located in the slot 42 in walls of the compartment 40 thus locating the earth spring 48 axially along the length of the EMI device 36. The outer legs 78 of the spring press against inner edges of the rectangular hole 30 in the cover
- 10 24 while the outer legs 78 also resiliently bear against the earth terminals 46 of the EMI device 36.

- Although only one preferred embodiment has been described, variations will be apparent to those skilled in the art and it is intended to cover all such variations as fall
- 15 within the scope of the appended claims.